The depth variations in seismic velocity and intermediate-depth seismicity in the subducting crust of the Pacific slab

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It is well known that active and localized seismicity called as the double seismic zone (e.g., Hasegawa et al., 1978) occurs in the Pacific slab. Additionally, Kita et al. (2006) discovered a concentrated seismicity at depths of 70-100 km associated with the upper plane of the double seismic zone in the Pacific slab beneath northeastern Honshu and Hokkaido, Japan. Dehydrated fluids from hydrous minerals in the subducting oceanic lithosphere are considered to play significant roles in these seismic activity in the slab (e.g., Kriby et al., 1996; Okazaki and Hirth, 2016). Therefore, revealing the dehydration depths of the hydrous minerals and presences of the dehydrated fluids would help us to understand seismogenesis of the intraslab earthquakes in detailed.
In this study, we investigated seismic velocity in the subducting crust located at the uppermost part of the Pacific slab beneath eastern Hokkaido, northern Japan, in order to reveal the distributions of fluids in the crust. At the eastern Hokkaido, guided waves propagating in the low-velocity subducting crust were often observed (Abers, 2005; Shiina et al., 2014). The guided waves are sensitive to the crustal heterogeneity because they propagate over a long distance in the crust. Thus, analyzing the guided waves could estimate seismic velocity in the crust with high accuracy. After we identified the guided-P and guided-S waves and visually picked those arrival times, we calculated Vp and Vs in the crust by using travel time differences of the guided waves and inter-event distances, as carried out by Shiina et al. (2014). In this study, 286 and 208 earthquake pairs for the guided-P and guided-S waves, respectively, are obtained from 315 intraslab earthquakes that occurred during from 2003 to 2011.
The obtained results show that Vp of 6.5-7.5 km/s and Vs of 3.6-4.2 km/s in the subducting crust at depths of 50-100 km beneath eastern Hokkaido. The Vp and Vs at depth of 50-70 km mark 6.5-6.8 km/s and 3.6-3.8 km/s, respectively, which are 10-15 % lower than those expected for the fully hydrated MORB materials (e.g., Kimura and Nakajima, 2014). The reductions in seismic velocity suggest that fluids of ~1 vol% are channeled in the subducting crust with the hydrous minerals beneath eastern Hokkaido, as well as beneath Tohoku, northeastern Honshu, Japan (Shiina et al., 2013).
At depths of ~80 km, on the other hand, increases in the Vp and Vs comparable to that values expected for the hydrated MORB (e.g., Kimura and Nakajima, 2014) are observed. The Vp of ~7.3-7.5 km/s at depths of 80-100 km is about 0.5 km/s faster than that estimated in Tohoku (Shiina et al., 2013). A straightforward interpretation for the regional variations in Vp, we consider that the change in the velocity would be proportional to the amount of fluids channeled in the crust. In this interpretation, the lower Vp in Tohoku implies that larger amount of fluids is trapped in the crust at the depths compare to that in eastern Hokkaido. According to Kita et al. (2006), crustal earthquakes that occurred at the depths of 80-100 km are more active in Tohoku than in eastern Hokkaido. These correlations between the seismic velocity and seismicity in the subducting crust suggest that the amount of fluids channeled in the crust closely links to the facilitation for activity of the crustal earthquakes at intermediate depths.

Keywords: oceanic crust, intermediate-depth earthquakes, fluid-related embrittlement, later phase

